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Dependence of Dust Formation on the Supernova Explosion and *nuDust*

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Dust is ubiquitous in the interstellar medium, serving as both a source of information and headaches to astronomers, depending on who you ask. The outflows of core collapse supernovae (CCSNe) serve as a factory for dust nucleation and are one of a few known sources of dust in the universe. From observations of local CCSNe such as 1987A and Cassiopeia A, we know that dust is abundant in CCSN ejecta prior to interacting with the ISM. Furthermore, the explosion energy, explosive engine, metallicity, and progenitor mass of the CCSN will all impact the subsequent dust formation history and composition. Observations of the supernova ejecta probe the detailed composition of the ejecta which, in turn, can be used probe the properties of the progenitor star and the process of the explosion.

We investigate the properties, composition, and dynamics of dust formation and growth for a diverse set of CCSNe, varying the progenitor mass, explosion energy, and engine type. These explosions are evolved with a 1-D Lagrangian hydrodynamics code out to several hundred days to model the ejecta as it expands and cools. A multigrain dust nucleation and growth model is applied to these results. We find that higher explosion energies lead to an earlier onset of dust formation, smaller grain sizes, and larger silicate abundances. Further, we see that nuclear burning during the explosion leads to enhanced formation of silicate dust. Finally, we build composite models from our suite to predict the efficiency of CCSNe dust production as a function of metallicity.

In an effort to accelerate this research, we extended the parallelism and vectorization capabilities of the open-source Python code *nuDust*. Exploiting the inherent data parallelism of Lagrangian hydrodynamics, we scaled *nuDust* from single-process execution to large-scale parallel execution on HPC machines at Los Alamos National Laboratory. We report on our methods for parallelism and results, and show promising initial work using on vectorization and offloading using NUMBA, a library for the just-in-time compilation of NumPy routines.